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Test sieving

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up has the right to be represented on that Committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 2591 was drawn up by Technical Committee ISO/TC 24, *Sieves, sieving and other sizing methods*, and circulated to the Member Bodies in December 1971.

It has been approved by the Member Bodies of the following countries :

Australia	Germany	Switzerland
Belgium	India	Turkey
Chile	Ireland	United Kingdom
Czechoslovakia	Romania	U.S.A.
Egypt, Arab Rep. of	South Africa, Rep. of	
France	Spain	

The Member Body of the following country expressed disapproval of the document on technical grounds :

Canada

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Test sieving

1 SCOPE AND FIELD OF APPLICATION

This International Standard discusses the main factors affecting test sieving and the results obtained, and specifies general principles to be followed concerning apparatus, procedure and presentation of results.

2 MATERIAL TO BE SIEVED

Materials to be test sieved range from very coarse lumps such as stone and coal to very fine materials such as pigments and clay, and vary in their physical and chemical properties. Information about the properties of a material is helpful in judging its sieving characteristics, and as far as possible these properties should be ascertained and noted in the test report. The more important properties affecting sieving are discussed below.

Because of the considerable variety of the material properties encountered, it is not possible to specify a single method of test sieving which applies to all materials. The sieving method appropriate to a material should be stated in the ISO document or national standard dealing with that material.

2.1 Physical and chemical properties

2.1.1 *Density*

The following kinds of density are important in test sieving :

- Effective particle density : Mass of a particle divided by the volume of the particle including open and closed pores.
- Apparent bulk density : The mass of the charge divided by its volume at the moment when it is placed on the sieving medium.

The effective particle density can affect the duration of sieving, whilst the apparent bulk density can influence the quantity of material to be taken for sieving.

2.1.2 *Friable nature*

Some materials are liable to size reduction during sieving due to their friable nature. This property should be taken into account in the handling of the material during sampling and test sieving.

2.1.3 *Abrasive properties*

Some materials, for example emery powders, are abrasive and wear out the sieves and change the apertures in the course of a prolonged sieving operation. It is desirable to ascertain whether or not the material is abrasive before commencing the test, and to check the conformity of the apertures of the sieving medium against the permitted tolerances.

2.1.4 *Moisture*

The following points are of importance :

2.1.4.1 Surface moisture

Surface moisture is important because it affects the way a material will flow on a sieve.

2.1.4.2 Internal moisture

If there is a change of internal moisture during sieving, the masses of the fractions will be affected.

2.1.4.3 Hygroscopic properties

Some materials readily absorb moisture and cannot safely be allowed to come into equilibrium with the laboratory atmosphere. In such cases they should be handled and sieved in such a way as to reduce their contact with the atmosphere to a minimum.

2.1.4.4 Changes on drying

It is important to know whether the properties of a material are changed by any proposed drying process, for example whether it is liable to break down or cake.

2.1.5 *Particle shape*

The duration and results of sieving can be considerably affected by the shape of the particles.

2.1.6 *Size distribution*

The range of particle size of the material is important in deciding the sieving procedure to be used (see section 4).

2.1.7 *Cohesive property*

The spreading of the particles on the sieving medium depends on the cohesive nature of the material. This in turn depends on the inter-particle friction and increases with the fineness of the powder.

2.1.8 *Magnetic properties*

Magnetic properties of materials may affect the results on account of the reactions of the particles with each other (tending to agglomeration) and with the sieve (tending to adhesion).

2.1.9 *Electrostatic properties*

Some powders may become charged with static electricity during the sieving operation and adhere to the sieve frame, thereby affecting the results.

2.1.10 *Chemical reactivity*

Certain materials may react with the atmosphere or with the material of the sieves. This aspect should be considered in choosing the sieve and in conducting the test.

2.1.11 *Production of material*

The source of the material and method of preparation may provide information on the properties discussed above. This information should be included in the test report.

2.2 Sampling method

2.2.1 *Method of taking samples*

Precise sampling is a necessary condition for obtaining accurate results for sieve tests. Therefore, just as much care should be taken with the sampling as with the actual sieving.

The method of sampling used should be such that the sample taken for sieving is truly representative of the material from which it has been drawn. The most suitable method will depend both on the material and on the form in which it is presented, for example whether it is in bags, in a heap or flowing as a continuous stream. It is not possible to specify one method that is applicable to all materials, and precise sampling methods should be specified for particular materials and circumstances.

The method of sampling shall follow the specifications laid down for individual products in ISO documents for these products; otherwise the methods laid down in national standards shall be followed.

2.2.2 *Division of the sample*

The original sample is often too large for direct use in a sieve test. It must therefore be reduced. In reducing the sample it is just as important to ensure that the final quantity (test sample) taken for sieving is truly representative of the original sample as it is to ensure that the original sample was representative of the material.

As in the case of original sampling, the division of samples of particular materials shall follow the ISO documents for the material, or, in the absence of such documents, the appropriate national standards.

2.2.3 *Storage of samples and test samples*

Samples and test samples should be stored in such a way that they are not liable to be contaminated or changed in any other way.

3 APPARATUS

3.1 Test sieves

Test sieving is carried out with a single test sieve or with a series of test sieves with different nominal aperture sizes. A lid and a receiver pan shall be included in both cases where appropriate. The number of sieves used in the test should be sufficient to give the requisite information about the material, and to avoid excessive wear or blinding.

3.1.1 *Test sieving media*

Wire cloth or perforated plate shall be used as the sieving media in test sieves. These shall conform to the relevant ISO documents.

The choice of the material of the test sieving medium is left to the user. It is, however, recommended that the same type of sieving medium (wire cloth or perforated plate) and the same geometrical form of the apertures be used for all the test sieves used in any one analysis.

3.1.1.1 Wire cloth

Woven wire cloth in test sieves shall be of plain weave with the exception of aperture sizes 63 µm and less where the weave may be twilled. The sieving medium must not have any weaving faults. It shall be mounted in the frame without distortion or creases.

Warp and weft wires shall be seen by visual inspection to be perpendicular to each other after mounting.

NOTE — A commonly accepted criterion is a maximum deviation of 3° from perpendicularity. Measurements shall be based on the mean direction of wires over several meshes.

3.1.1.2 Perforated plates

Holes in perforated plates shall be cleanly formed. The plates shall be mounted punch side uppermost.

3.1.2 *Test sieve frame*

3.1.2.1 Shape and size of the test sieve frame

The types given in Table 1 are recommended.

TABLE 1 – **Frame sizes**

Dimensions in millimetres

Nominal shape and size of test sieve	Width of effective sieving surface		Approximate depth
	min.	max.	
Round, diameter 200	185	200	50
Round, diameter 300	275	310	75
Square, 300	275	310	75

It is recommended that the 200 mm round frame should be used as far as possible, especially for wire cloth up to 1 mm nominal aperture size. A smaller round frame may be appropriate for very fine sieves and for very small quantities of material. For large aperture sizes the 300 mm round or square sieve may be required, or even larger sieves for aperture sizes greater than 25 mm and large sample quantities. The shape and size of the sieve have little effect on the results of the sieving operation.

The choice of the shape and of the size shall be stated in the test report.

3.1.2.2 Construction of the test sieve frame, lid and receiver

The test sieve frames shall nest snugly with each other and with the lid and the receiver of the same type. The frame shall be smooth and the seal of the sieve so constructed as to prevent lodging of the material to be sieved.

3.1.2.3 Marking of the frame

The label attached to the sieve shall give the following details :

a) the nominal aperture size;

b) a reference to the standard(s) with which the test sieve is claimed to comply;

c) the material of the sieving medium and the material of the frame;

d) the name of the firm (manufacturer or vendor) taking responsibility for the sieve;

e) an identification number.

3.1.3 *Preparation and maintenance of the test sieve*

Before use, the sieving medium and frame shall be degreased and cleaned. The cleaning of the sieve should be carried out with great care so that the sieving medium is not damaged. (Cleaning by ultrasonics, for example.)

The accuracy of the sieving medium in the test sieve shall be verified initially, and subsequently reverified in course of use. Factors such as the frequency of use and type of material sieved will influence the frequency of the verifications. It is desirable, therefore, to have a record card for each test sieve.

Verification and reverification may be made by the procedure described in ISO . . .[1].

Another method is to compare the performance of the sieve with the performance of a reference sieve, using a sample material similar to the one for which the test sieve is to be used.

Another method is available for a sieve which has been tested with calibrated glass spheres. It may be retested at any time to verify that its condition is maintained.

When a sieving medium no longer complies with the tolerances specified, the marking on the label shall be cancelled and the sieve discarded.

3.2 Accessories

Depending on the material characteristics and the particle size distribution of the sample to be tested, the following auxiliary apparatus may be necessary :

– for dry sieving : a soft brush, for example a paint brush, to clean the underside of the sieving medium from time to time.

– for wet sieving : an installation with liquid reservoir, regulating valve and collecting tank.

For test sieving purposes the use of devices such as balls and chains added to the material is not permissible.

4 PROCEDURE

4.1 General considerations

Test sieving can be carried out by hand or with the aid of test sieving machines. If test sieving machines are used, they shall be so constructed and operated that the sieving results conform within agreed tolerances to those obtained by hand sieving. The reference method shall always be hand sieving, performed under specified conditions.

The following conditions should be laid down beforehand :

– method of sieving, dry, wet or a combination of both;

– number of sieves to be used and their aperture sizes;

– sequence of the sieves to be used (usually coarse to fine, more rarely fine to coarse).

For special cases when only machine test sieving is carried out, the machine and method of operation shall be stated in the test report.

1) In preparation.

Test sieving by hand should normally be performed on the whole test sample with sieves up to 25 mm aperture size. Above 25 mm the particles can be presented individually by hand to the apertures.

The test sample may be divided into fractions by a preliminary sieving into the following particle size ranges :

larger than 25 mm
25 to 4 mm
4 to 1 mm
smaller than 1 mm

The test sieving procedures for materials within these different size ranges are given in 4.6.

The charges (see 4.4) should be taken by sub-dividing the fractions obtained by the preliminary sieving. If, however, the charges do not ensure a representative sample, the whole fraction in the size range under consideration shall be tested.

If test sieving over more than one of the above size ranges is required, the individual fractions shall be recorded in mass percentages of these ranges, and in the final evaluation converted to mass percentages of the sum of all the fractions collected (see 4.9.2).

The procedure consists in gently placing the material to be sieved on the test sieve with a specified nominal aperture size and separating the material by shaking, tapping or washing, into oversize and undersize. In sieving successively with test sieves of different aperture sizes the test sample is separated into size fractions designated by the aperture sizes of the test sieves used (see 5.1.1).

For hand test sieving the following procedures are known :

– dry sieving : by shaking and tapping (the procedure suitable for most materials).

– wet sieving : by washing (for materials which tend to agglomerate).

The hand sieving process may be adapted to the sieving characteristics of the sample concerned by choosing from these alternatives.

The sieving of particles smaller than 1 mm may be facilitated by starting with the finest test sieve, so that the coarse particles in the charge may aid the sieving process. As is well known, the sieving of fine particles on a fine test sieve can be difficult owing to the tendency of the apertures to blind. Care shall be taken, however, to avoid the presence of excessively coarse particles as these may easily damage the sieve (see 4.5).

Extremely fine particles (such as those encountered in the determination of the grit content in soot) or particles which charge themselves with static electricity (for example, some plastics powders), or damp dust which cannot be dispersed, shall be sieved wet.

The effectiveness of dry test sieving depends on

– the duration of sieving;

– the tapping force;

– the number of taps per minute (frequency);

– the tapping direction;

– the amplitude of shaking;

– the inclination of the sieve surface.

The effectiveness of wet test sieving depends on

– the duration of sieving;

– the liquid;

– the wetting agent used (if any);

– the intensity of the washing action;

– the intensity and nature of the movement of the sieve if sieving is carried out by moving the sieve in the liquid.

4.2 Weighing precision for the material to be sieved

It is recommended that the masses of the charge and the fractions should be determined to a precision of at least ± 0,1 % of the mass of the charge.

4.3 Influence of the humidity of the air

Samples to be dry-sieved, other than those mentioned in 2.1.4.3, shall be in a state of equilibrium with the laboratory atmosphere. This is achieved by the method best suited to the product. If there is a change of humidity during the test, the masses of the charges and fractions shall be corrected to their dry masses.

4.4 Test sample and charge

4.4.1 *Test sample*

The recommended quantity of material to be sieved on a 200 mm round sieve is given for guidance in Table 2, column 2 for R 20/3 sizes between 22,4 mm and 45 μm.

The quantity should be that indicated for the sieve corresponding to the dominant size fraction of the sample, providing that the size distribution does not cause excess volume on any of the sieves in the set as indicated in column 3.

The values given in Table 2 apply equally to single sieves and nests of sieves, and to hand sieving and machine sieving.

4.4.2 *Charge*

The quantity of material to be placed on the sieve depends on

– the sieve aperture size;

– the apparent bulk density of the material;

– the cross-sectional area of the sieve;

– the proportion of oversize material (determined if necessary by preliminary sieving).

The proportion of oversize material shall be such that the volume retained on the sieve after completion of sieving is not greater than that recorded in Table 2, column 3. It may be necessary, therefore, to sieve a test sample in two or more charges to avoid exceeding the volume. The results shall be combined.

For obtaining best results, it is always preferable to place a reduced charge on the coarser aperture sieve to avoid overloading any of the finer aperture sieves in the set.

If any of the important fractions do not contain a sufficient number of particles to be representative of the bulk material, then sieving shall be repeated with further charges until this fraction is sufficient.

4.5 Largest particle permitted on a test sieve

To avoid damage to the sieve, the size of the largest particle in the charge shall not exceed

$$10\,w^{0,7}\ \text{mm}$$

where w is the nominal aperture size.

Examples

Nominal aperture size w	Approximate size of largest particle
25 mm	95 mm
11,2 mm	55 mm
4 mm	26 mm
1 mm	10 mm
250 µm	3,8 mm
45 µm	1,2 mm

4.6 Methods and sequences of operation

4.6.1 *Particles larger than 25 mm*

For particles larger than 25 mm the test sieve serves essentially as a gauge, to which the particles are individually presented to one of the apertures.

A charge appropriate to the sieve may first be screened by gentle shaking. The particles remaining on the sieve are then checked one by one in all positions without applying force. Those that pass are included in the passing fraction. Those that do not pass become the residue.

4.6.2 *Particles 25 to 1 mm*

Particles above 4 mm are preferably tested on each sieve individually and not with a nest. Below 4 mm the sieves may be nested.

TABLE 2 – **Quantity of material for test sieving on a 200 mm round sieve**[1)]

1	2	3
	Bulk volume of material[2)]	
Nominal aperture size w	**Recommended volume of charge**	**Maximum volume of residue permitted on the sieve at the completion of sieving**
mm	cm³	cm³
22,4	1 600	800
16	1 000	500
11,2	800	400
8	500	250
5,6	400	200
4	350	150
2,8	240	120
2	200	100
1,4	160	80
1	140	70
µm		
710	120	60
500	100	50
355	80	40
250	70	35
180	60	30
125	50	25
90	40	20
63	35	17
45	30	15

1) When using test sieves of different shapes and sizes, the values should be modified accordingly.

2) Masses of materials can be determined by multiplying the values in columns 2 and 3 by the apparent bulk density (g/cm³) of the material to be sieved.

Two procedures are permissible :

a) A fresh charge is sieved through each sieve in turn. (See Table 2 for recommended sample quantities).

b) A fresh charge is used only on the sieve with the largest nominal aperture size. The material which passes through this sieve is used as the charge for the test sieve with the next smallest nominal aperture size, and so on. (This is a similar sieving process to that with a test sieve nest.)

The test sieve, or the test sieve nest, (sieves 4 to 1 mm) is taken with both hands and moved to and fro horizontally about 120 times per minute at an amplitude of about 70 mm.